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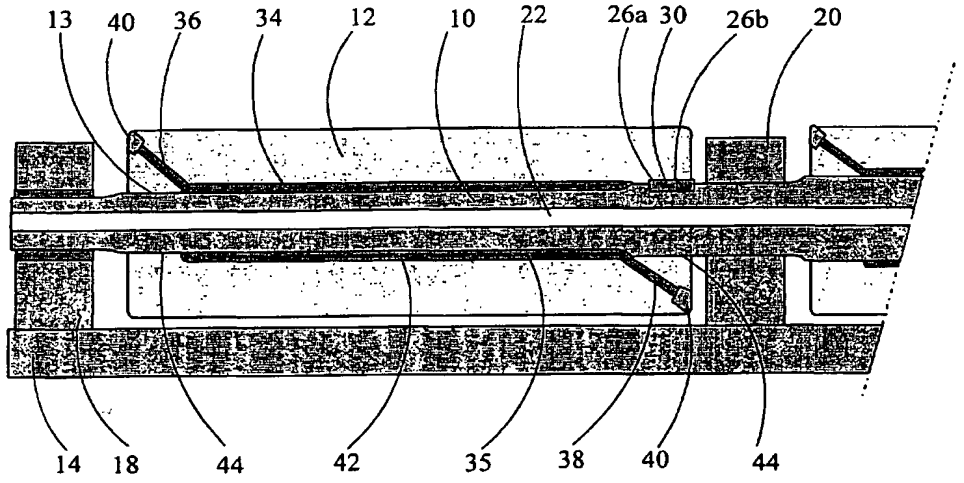
(54) Title: ROLLER WITH INTERMEDIATE BEARINGS



(57) Abstract: The invention relates to a roller functioning as an element in a roller track and having an axle (10) to which replaceable jackets (12) are attached. The axle is attached to the body (14) of the roller track by means of end bearings (18) and intermediate bearings (20). To cool the roller, cooling liquid is directed to flow in the cooling channel (22) running through the axle. Between the inner surface of the jacket and outer surface of the axle there is a cavity (35) surrounding the axle, filled with a filling compound (42). Because of the cavity, the contact surface between the jacket and axle is small, making it easier to remove the jacket. The filling compound enhances heat transfer at the interface between the jacket and axle and serves as a lubricant when the jacket is being replaced. In an advantageous embodiment of the invention cooling liquid is directed to flow through the cavity between the jacket and axle.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Roller with intermediate bearings

The invention relates to a roller arranged to function as an element in a roller track and having an axle through which a cooling channel runs, to which axle replaceable jackets are attached by fitting the axle so as to run through the jacket and which axle is supported by a body through end bearings and intermediate bearings.

Metal strands are cast using a continuous casting technique in which molten metal is first poured into a funnel-like mould, so-called chill, from where the strands are taken onto a strand guide comprising two parallel roller tracks. While travelling between the roller tracks the strand gradually cools down to its final shape. A strand travelling between the roller tracks with a slightly cooled surface only has got a thin solid strand skin while inside the strand the metal is molten. Rollers supporting the strand have to be placed very densely in order to prevent the strand skin of the strand from bursting and molten metal from running down between the rollers. To that end the rollers have relatively small diameters; usually from 220 to 300 mm. In the casting of wide sheet metal strands it is customary to use rollers with intermediate bearings so that several cylindrical jackets are attached to a single axle. The intermediate bearings give the long roller with a thin cross-section a sufficient bending stiffness.

Fig. 1 shows, in a side view, a prior-art roller with intermediate bearings. A continuous axle 10, around which there are jackets 12, runs in the centre of the roller through the whole length of the roller. In Fig. 1 there are three jackets but the number is not limited to three. The jackets are usually less than 700 mm long and their walls are about 70 to 100 mm thick. The axle is supported at its ends by end bearings 18 and between the jackets by intermediate bearings 20 attached to the roller track body 14. The jackets 12 attached to a given axle have different lengths so that at successive rollers of a roller track the intermediate bearings can be placed at different locations in the longitudinal direction of the axle. To cool down a roller a cooling channel 22 runs through the centre part of the axle in the longitudinal direction of the axle and a cooling liquid flows through the said cooling channel. At the ends of the cooling channel there are pipe connectors 24 connecting the cooling channel to a cooling system. The cooling liquid flows into the channel at one end of the channel and flows out at the other end of the channel.

As an example, Fig. 1b shows a cross-section of one end of a prior-art roller. A jacket is a cylindrical part having at its centre a hole 13 the size of which matches

the outer diameter of the axle. Throughout the whole length of a jacket the inner surface of the jacket is in contact with the outer surface of the axle so that the heat in the jacket be transferred, through the contact surfaces, as effectively as possible to the axle and further to the cooling liquid flowing in the cooling channel. Throughout the whole length of a jacket the axle has a uniform thickness but it includes tapered sections where the cross-section of the axle changes. The axle is thus at its thickest at the middlemost jacket and at its thinnest at the ends of the axle. Adaptor elements 16 can be installed around the axle at the end bearings so that a single bearing size fits the whole axle. A jacket is attached in a fixed manner to the axle using a locking wedge 30 so that the jacket always rotates at the same speed as the axle. Because of the fixed attachment between the axle and jacket a roller may also be arranged so as to be tractive by having a motor to turn it at an end of the axle. Indeed, double roller tracks in continuous casting plants are usually assembled using packages where a body element has e.g. five upper rollers and five lower rollers attached to it, one roller pair of which is tractive and the other ones free-rolling.

Prior-art cooled rollers with intermediate bearings suffer from several disadvantages. Heavy strands wear and scratch the surfaces of the jackets quickly so that the jackets have to be replaced or repaired periodically. The intermediate bearings, too, have to be serviced regularly, which means the rollers have to be disassembled from time to time. Jackets are removed from the axle by pulling them off the axle as a whole. Removal work is slow and hard as the jackets sit on the axle very tight and because the contact surface between a jacket and the axle extends through the whole length of the jacket. Removal work usually requires that the jacket be heated so that thermal expansion would make it easier to remove. In spite of heating, the jacket may seize up on the axle so that the entire axle has to be replaced. Moreover, the surface of the axle is easily scratched in the removal work which affects thermal conduction between the new jacket and the axle. In addition, the thermal transfer characteristics of new or repaired rollers are always uneven because the width of the gap between the axle and jacket varies due to manufacturing tolerances of these elements.

It is an object of the invention to provide a cooled roller with intermediate bearings having a novel construction to reduce the said disadvantages and drawbacks related to the prior art. A roller with intermediate bearings according to the invention is characterized by what is specified in the independent claim. Some advantageous embodiments of the invention are specified in the dependent claims.

In the invention, a roller functioning as an element in a roller track comprises an axle with replaceable jackets attached to it. The axle is coupled at its ends to the roller track body through end bearings and, between the jackets, through intermediate bearings. The basic idea of the invention is that a jacket is in contact with the outer surface of the axle not by the whole length of the jacket but only at both ends of the jacket. Thus in the middle section of the jacket there is a ring-like cavity around the axle. Because of the cavity, the jacket is in contact with the surface of the axle only by a short length, which makes it easier to remove the jacket off the axle.

In an advantageous embodiment of the invention the cavity formed between the outer surface of the axle and inner surface of the jacket is filled with a filling compound having a good thermal conductivity, improving thermal transfer from the jacket to the axle and further to the cooling channel.

In another advantageous embodiment of the invention the cooling liquid flowing in the cooling channel of the axle is directed so as to flow in the cavity between the jacket and the outer surface of the axle.

An advantage of the invention is that the thermal transfer characteristics of the rollers become uniform. Because of the uniformity, all jackets in a roller can be held at approximately the same temperature by means of cooling. This way, the jackets will have a longer life and all jackets wear evenly.

An advantage of the invention is that it makes service work on the roller track quicker to complete. The invention makes it easier to remove the jackets of a roller with intermediate bearings, bringing about savings in service costs.

Another advantage of the invention is that the risk of scratching the axle and the danger of the jacket seizing up is substantially reduced. This makes the service life of the axle and jacket longer and results in savings in materials and spare parts costs.

A further advantage of the invention is that as thermal transfer from jacket to axle is improved, the cooling of the whole roller becomes easier. Improved thermal transfer characteristics make it possible to reduce cooling liquid circulation, thus bringing about savings in energy costs and cooling equipment investment costs.

The invention is below described in detail. The description refers to the accompanying drawings in which

Figs. 1a and 1b show a prior-art roller with intermediate bearings,

Fig. 2 shows by way of example a cross-section of one end of a roller with intermediate bearings according to the invention, and

Fig. 3 shows by way of example a cross-sectional view of an advantageous embodiment of a roller with intermediate bearings according to the invention.

As an example, Fig. 2 shows a cross-section of one end of a roller with intermediate bearings according to the invention. The roller comprises an axle 10 around which there are jackets 12. In order to make it easier to install jackets and bearings on the axle as well as remove them from the axle, the axle is designed such that it becomes, in a stepwise manner, thinner towards the both ends. A cooling channel 22 parallel to the axle runs through the centre part of the axle. The jacket 12 is advantageously a cylindrical part made from a single solid piece of metal having a hole 13 at the centre in the longitudinal direction of the jacket. The jacket is attached in a fixed manner to the axle by means of a locking wedge 30. The attachment of a jacket is begun by first placing a locking wedge onto a locking groove 26b on the outer surface of the axle. The thickness of the locking wedge is such that one edge thereof remains in sight when it is in its place in the locking groove 26b. After that the jacket is pushed into its place so that one edge of the locking wedge slips onto a locking groove 26a at one end of the hole 13 in the jacket, locking the jacket in place. Naturally, a jacket may be attached using a plurality of locking wedges. In that case the locking grooves and wedges are advantageously placed at regular intervals around the axle. The fixed attachment makes the jacket always rotate at the same speed as the axle. The roller may also be rotated by one or both ends by a motor, in which case the roller is tractive.

In the invention, the hole 13 through the jacket 12 has a varying diameter. At both ends of the jacket the diameter of the hole is substantially equal to the outer diameter of the axle running through the jacket but in the middle part of the jacket the diameter of the hole is slightly bigger than the outer diameter of the axle. Thus the wall of the hole 13 in the jacket is in contact with the outer surface of the axle only by the width of the narrow necks 44 formed at the ends of the jacket. The width of these necks can be selected suitable in the manufacturing stage of the jackets. Advantageously the necks are 5 to 10 cm wide. In the middle part of the jacket there is a gap 34 between the wall of the hole and the outer surface of the axle, the width of the gap being freely selectable.

The gap between the jacket and the axle forms a continuous cavity 35 with a ring-like cross-section, extending from the vicinity of one end of the jacket to the vicinity of the other end of the jacket. The cavity is filled with a filling compound 42 consisting of a paste-like substance with a good thermal conductivity. Advantageously the filling compound is a metal paste such as copper paste or molybdenum paste with a glycol-based oil as a binding agent. In addition, the filling compound may include graphite as a lubricant. The primary function of the filling compound is to serve as a thermal conductor between the wall of the jacket and the axle. The filling compound transfers heat effectively across the interface between the jacket and axle as the filling compound fills the cavity completely. Thus, grooves and scratches on the surface of the axle 10 or on the surface of the hole 13 in the jacket or inaccuracies in the dimensions of the elements will not decrease the thermal conductivity.

The filling compound is inserted in the cavity after mounting the jacket on the axle 10. For inserting the filling compound there is a filling hole 36 at one end of the jacket, extending through the wall of the jacket 12 to one end of the cavity 35. Similarly, there is an observation hole 38 at the other end of the jacket, extending from the outer surface of the jacket to the other end of the cavity 35. As much of filling compound as the cavity holds is injected by means of a compressor gun or a similar tool into the cavity. As "excess" filling compound tries to come out of the cavity through the observation hole, the cavity is full and the ends of the filling hole and exit hole are blocked with plugs 40. The cavity is dimensioned such that the gap 34 between the outer surface of the axle and hole 13 is as small as possible so that a minimum amount of filling compound is needed. However, the gap shall be big enough for the filling compound to enter the gap smoothly and fill up the cavity completely. Fig. 2 shows only the jacket 12 nearest to the end of the axle. The other jackets attached to the axle are similar in construction, only the lengths of jackets may vary. Naturally, the size of the hole running through the jacket varies according to how the diameter of the axle changes in the longitudinal direction of the axle.

The disassembly of and replacement of jackets in a roller with intermediate bearings according to the invention is quick. First, an end bearing 18 is removed from the axle by pulling it out towards the end of the axle. After that the jacket 12 is pulled off the axle. The pulling off of the jacket is easy since the jacket is in direct contact with the outer surface of the axle only by the width of the necks 44 at both ends of the jacket. As the jacket has moved towards the end of the axle by the width of the neck the gap between the contact surfaces becomes so large that no great force is

required any more to pull the jacket off the axle. The axle becomes in a stepwise manner thinner towards the end so that at the neck at a first end of the jacket the axle is thinner than at the neck at a second end of the jacket. Thus the necks are in contact with the outer surface of the axle only during the initial phase of the removal of the jacket. During the removal the filling compound serves as a lubricant and prevents the contact surfaces from being scratched. After the removal of the first jacket the locking wedge 30 is removed from the locking groove 26b and, after that, the first intermediate bearing 20 and the next jacket are removed. This goes on in a like manner until all the jackets and bearings have been removed. Symmetrical axles are usually used in the rollers, which are at their thickest in the middle section of the axle and thin down in a stepwise manner towards the both ends. In that case the roller is naturally disassembled in two directions starting at the ends.

Fig. 3 shows by way of example a cross-sectional view of an advantageous embodiment of a roller with intermediate bearings according to the invention. In this embodiment the jacket 12a is otherwise similar to the embodiment depicted in Fig. 2, but it does not include a filling hole 36 or observation hole 38. Nor is the cavity 35 between the inner surface of the jacket and outer surface of the axle filled with a filling compound. In this embodiment the axle includes entrance holes 46 and return holes 48 leading radially from the cooling channel 22 through the wall of the axle to the cavity 35. In the longitudinal direction of the axle the holes are placed so that when the jacket is in its place around the axle the entrance holes are located in the vicinity of one end of the cavity and the return holes are located in the vicinity of the other end of the cavity.

Inside the cooling channel there is in the section between the entrance holes and return holes a plug 50 for each jacket, preventing the cooling liquid from flowing in the cooling channel. Advantageously the plug may be simply a length of a round bar. In this advantageous embodiment of the invention the cooling liquid at first flows from one end of the axle into the cooling channel 22. At a point where there is a jacket the cooling liquid flows through the entrance holes 46 into the cavity 35, and through the return holes 48 from the cavity back into the cooling channel. The path of the cooling liquid is similar for each jacket on the axle. The sizes and number of entrance holes and return holes as well as the width of the gap 34 are advantageously selected such that the cross-sectional area of the path of the cooling liquid remains approximately the same for the whole length of a roller. In this embodiment the cooling of the jacket is very efficient as the heat of the jacket is transferred direct from the jacket to the cooling water. If necessary, gaskets 52 may be installed at

the interfaces between the axle and jacket to seal up the cavity 35. The gasket may advantageously be a ring gasket installed around the axle 10 in a groove machined on the contact surface between the necks 44 and the outer surface of the axle.

The cooled roller with intermediate bearings according to the invention described above is particularly well suited to be used as an element in roller tracks of continuous casting lines in steel and metal industry, but it may be used in roller tracks intended for other uses as well. Because of the thermal transfer characteristics of the roller it is especially well suited for applications in which a heated roller is needed. In such a case liquid at a suitable temperature is directed into the cooling channel instead of cooling liquid in order to raise the temperature of the roller to a desired level.

Above it was described a few advantageous embodiments of a roller with intermediate bearings according to the invention. The invention is not limited to the solutions described here but the inventional idea may be applied in many ways within the scope defined by the claims.

Claims

1. A roller arranged to function as an element in a roller track and having an axle (10) through which a cooling channel (22) runs, to which axle replaceable jackets (12, 12a) are attached by fitting the axle to run through a hole (13) in the jacket and which axle is supported by a body (14) through end bearings (18) and intermediate bearings (20), **characterized** in that there is between the inner surface of the jacket and outer surface of the axle a cavity (35) around the axle.

2. A roller according to claim 1, **characterized** in that the cavity (35) is produced by making the hole (13) which runs through the jacket (12, 12a) such that it has a varying diameter so that the diameter of the hole is substantially equal to the diameter of the axle (10) at both ends of the jacket and greater than the diameter of the axle in the middle section of the jacket.

3. A roller according to claim 1 or 2, **characterized** in that the cavity (35) contains filling compound (42).

4. A roller according to claim 3, **characterized** in that the filling compound (42) is a paste-like substance with a good thermal conductivity in order to enhance the thermal transfer between the jacket (12) and axle (10).

5. A roller according to claim 4, **characterized** in that the filling compound (42) is metal paste with a glycol-based oil as a binding agent.

6. A roller according to claim 5, **characterized** in that the metal constituent in the filling compound (42) is copper.

7. A roller according to claim 5, **characterized** in that the metal constituent in the filling compound (42) is molybdenum.

8. A roller according to any one of claims 3 to 7, **characterized** in that the filling compound (42) contains graphite.

9. A roller according to any one of claims 3 to 8, **characterized** in that the jacket (12) has a filling hole (36) and observation hole (38) for the insertion of filling compound (42) into the cavity (35).

10. A roller according to claim 1 or 2, **characterized** in that the axle (10) has entrance holes (46) and return holes (48) for directing cooling liquid from the cool-

ing channel (22) into the cavity (35) and from the cavity back into the cooling channel.

11. A roller according to claim 10, **characterized** in that at the cavity (35) the cooling channel (22) is blocked by a plug (50) in the section between the entrance holes (46) and return holes (48).

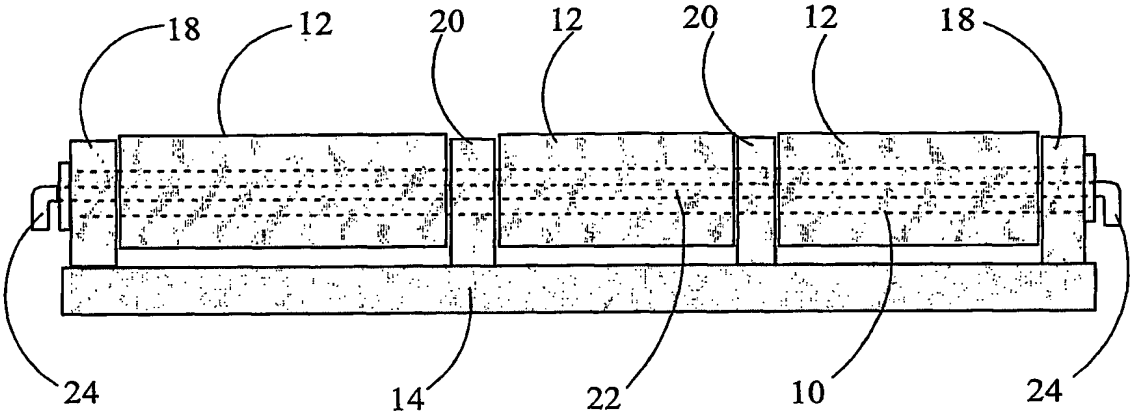

Fig. 1a Prior art

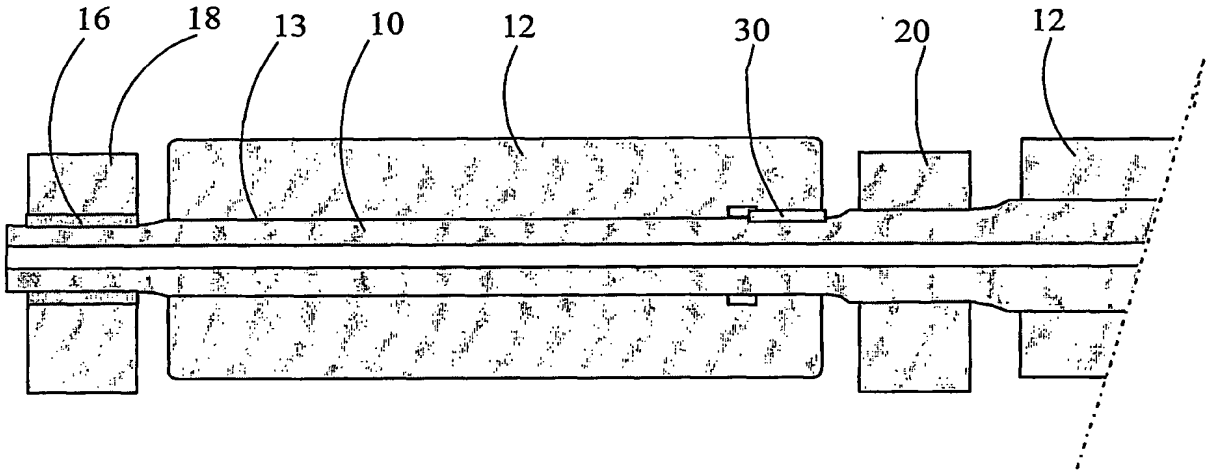

Fig. 1b Prior art

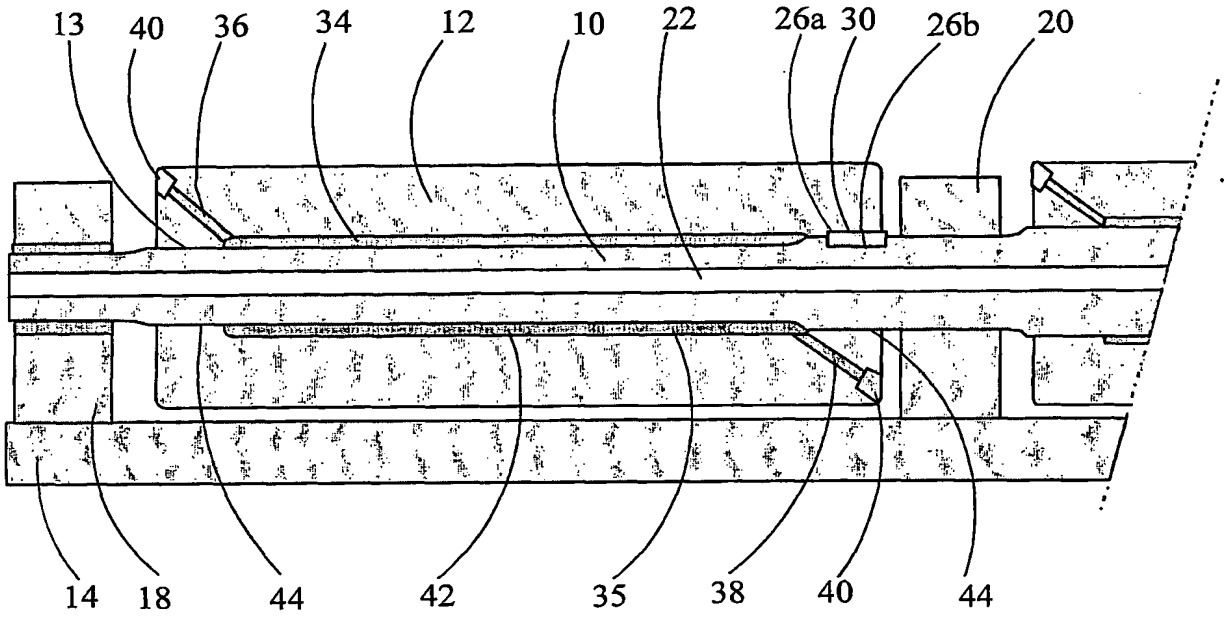
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Fig. 2

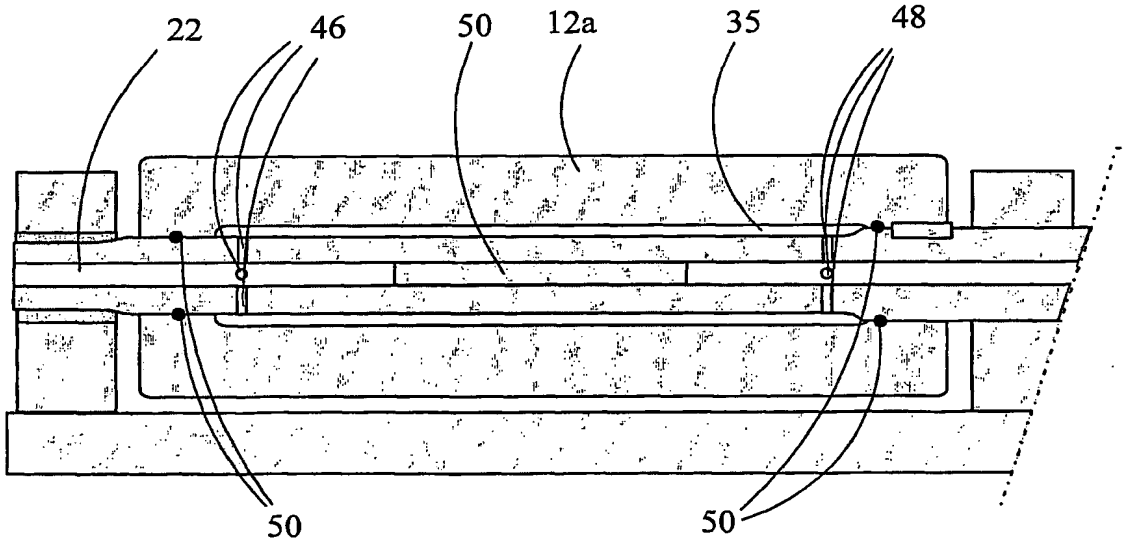
22
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Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/00958

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16C 13/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16C, B22D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 2552969 A1 (KLÖCKNER-WERKE AG), 2 June 1977 (02.06.77), figure 1	1,2,10,11
X	DE 19744077 A1 (SMS SCHLOEMANN-SIEMAG AG), 8 April 1999 (08.04.99), figure 1, details 7-9	1,3-9
A	US 4137963 A (LANGER ET AL), 6 February 1979 (06.02.79), figures 1-3	1-11

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 January 2002	18 -02- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jan-Axel Ylivainio / JA A Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

Information on patent family members

06/11/01

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2552969 A1	02/06/77	NONE	
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